

**EPA Superfund
Record of Decision:**

**LANGLEY AIR FORCE BASE/NASA LANGLEY
RESEARCH CENTER
EPA ID: VA2800005033
OU 42
HAMPTON, VA
01/14/1999**

RECORD OF DECISION

LANGLEY AIR FORCE BASE

OPERABLE UNIT 42 (OT-38 AREA A AND AREA B)

DECLARATION

SITE NAME AND LOCATION

Langley Air Force Base
Operable Unit 42 (Installation Restoration Program [IRP] Site OT-38 Area A and Area B)
Hampton, Virginia

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected remedial action for Operable Unit (OU) 42 at Langley Air Force Base (AFB) in Hampton, Virginia, chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, 42 U.S.C. §§59601-9675 and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR 300. This decision is based on the Administrative Record for this site.

The Virginia Department of Environmental Quality (VDEQ) concurs with the selected remedy.

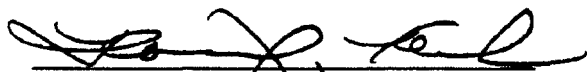
DESCRIPTION OF THE SELECTED REMEDY

OU-42 is part of a comprehensive environmental investigation and cleanup currently being performed at Langley AFB under the CERCLA program. This ROD addresses only OU-42; the other OUs located at Langley AFB are being investigated separately under its installation restoration program and will be addressed in future RODs. Also, this ROD addresses only soils at the OU. The groundwater is being treated as a separate OU and will be addressed on an installation-wide basis.

Langley AFB, EPA, and VDEQ have determined that no action is necessary for this site. Risk assessment results indicate that OU-42 soils do not pose an imminent or substantial danger to public health, welfare, or the environment.

DECLARATION OF STATUTORY DETERMINATIONS

Risk assessment results from the remedial investigation (RI) performed at the OU indicate that No Action is necessary to be protective of human health and the environment.



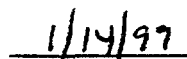
THOMAS J. KECK
Lieutenant General, USAF
Vice Commander, Air Combat Command



Date



ABRAHAM FERDAS
Director
Hazardous Site Cleanup Division
U.S. Environmental Protection Agency
Region III



Date

RECORD OF DECISION
LANGLEY AIR FORCE BASE
OPERABLE UNIT 42 (OT-38 AREA A AND AREA B)

December 1998

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
I. Site Name, Location, and Description	1
II. Site History	2
III. Highlights of Community Participation	3
IV. Scope and Role of Operable Unit	4
VI. Summary of Site Characteristics and Extent of Contamination	5
VII. Current and Potential Future Site and Resource Uses	11
VII. Summary of Site Risks	11
VIII. Significant Changes from Proposed Plan	14
IX. Responsiveness Summary	14

APPENDIX A

Table	Title
1	Summary of Operable Units Under CERCLA Investigation
2	Exposure Parameters and Equations Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors at Langley AFB, Virginia
3	Human Health Risk Assessment Summary for OU-42 (OT-38 Area A and Area B)

APPENDIX B

Figure	Description
1	Location Map, Langley Air Force Base, Virginia
2	Base Map of Langley AFB Showing the Location of the Site (OT-38 Area A and Area B/OU-42) and CERCLA OUs
3	OT-38 Area A Sampling Locations
4	OT-38 Area A Direct Push Soil Results Greater than RBSLs and Background UTLs
5	OT-38 Area B Sampling Locations

APPENDIX C

Glossary

APPENDIX D

References

List of Acronyms

AFB	Air Force Base
bgs.	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
COPC	chemical(s) of potential concern,
COPEC	constituent(s) of potential environmental concern
EF	degrees Fahrenheit
DOD	U.S. Department of Defense
EPA	U.S. Environmental Protection Agency
HI	hazard index
IRA	interim removal action
IRP	Installation Restoration Program
IT	IT Corporation
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OU	Operable Unit
PCB	Polychlorinated biphenyl
ppm	part(s) per million
PRG	Preliminary Remediation Goal
RI	Remedial Investigation
ROD	Record of Decision
RME	Reasonable Maximum Exposure
SI	site inspection
Versar	Versar, Inc.
VDEQ	Virginia Department of Environmental Quality

RECORD OF DECISION

LANGLEY AIR FORCE BASE

OPERABLE UNIT 42 (OT-38 AREA A AND AREA B)

DECISION SUMMARY

I. Site Name, Location, and Description

Langley Air Force Base (AFB) is located near Hampton, Virginia, which is part of the Norfolk metropolitan area, as shown in Figure 1 (Appendix B). The base, which covers 3,152 acres, was established in 1917 and has the distinction of being the oldest continuously active AFB in the United States. The base is situated between the northwest and southwest branches of the Back River, a tidal estuary of Chesapeake Bay.

Operable Unit 42 (OU-42) consists of two former bum pit areas known as OT-38 Area A and OT-38 Area B. The two areas are located within the central portion of the AFB (Figure 2). The surrounding land use is primarily open space and industrial areas. A description of the two areas taken from the remedial investigation (RI) report¹ is provided below:

A. OT-38 Area A

Area A comprises a bum pit, which was originally believed to be close to the RV (recreational vehicle) storage compound just northwest of the main runway (Figure 2). This area was used during the late 1940s. However, aerial photographs dating from 1942 contained evidence of possible bum pits located in pastureland to the southwest of the area originally indicated. An open area, approximately 200 feet long by 100 feet wide, containing a flat square structure either with elevated sides or with a fence around it, was identified in an aerial photograph. This area also contained two smaller circular structures, one with elevated sides and the other with a topographic depression within its circumference. The circular depression may have been the burn pit. There is no evidence of the presence of the pits or the associated structures in the subsequent aerial photographs dating from 1944 to 1990. The boundaries of OT-38 Area A were redrawn to reflect this information. Access to the area was via an unpaved road leading from Durand Road.

B. OT-38 Area B

Area B was reported to have been located immediately east of Weyland Avenue, near Building 1096 and 1097. The area was apparently used from about 1917 to the mid-1940s. Aerial photographs of the area, dating from 1937 to 1990, contain no evidence of a pit at this location. A photograph dating from 1937 does, however, contain evidence of two non-vegetated, circular features surrounded by grass and scrub vegetation located approximately 300 feet southwest of this area. These features may, in fact, have been the burn pits. The boundaries of OT-38 Area B were redrawn to reflect this information.

II. Site History

This section describes the history of waste disposal in addition to actions taken in response to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) investigations at OU-42.

A. History of Waste Disposal

The mission of Langley AFB has changed during its history. To support its various missions, quantities of petroleum, oils, and lubricants (POLs), solvents, pesticides, photographic chemicals, and protective coatings have been used. Some of the resulting wastes were disposed of in burn pits such as OU-42. The two pits were used primarily for burning waste oil and trash resulting from mission activities of Langley AFB. The years of operation for OT-38 Area A were during the late 1940s and for OT-38 Area B were from about 1917 to the mid-1940s. No interim actions have been performed at this OU.

There are currently 23 other OUs being investigated at Langley AFB. Figure 2 provides the location of these arew. Table 1 (Appendix A) provides a brief summary of these OUs.

B. CERCLA Investigations

Three CERCLA investigations have been performed at the OU. The OU was originally identified during the 1981 Installation Restoration Program (IRP) records search but was not recom-

mended for investigation at that time². The second investigation was the site inspection (SI) and screening risk assessment³. This report was used to determine the presence or absence of contamination at OT-38 resulting from past waste disposal practices. The SI indicated that chemicals of potential concern (COPCs) at Area A included metals and semivolatile organic compounds (SVOCs). COPCs at Area B were several metals. Also, some of the ecological COPCs were identified as having high bioconcentration and biomagnification potential.

The third CERCLA investigation was the RI¹. The RI was performed to further characterize potential environmental contamination from the OU and to conduct baseline human health and ecological risk assessments. The results of the RI indicated that the OU does not pose an unacceptable risk to human health or the environment.

III. Highlights of Community Participation

In accordance with Sections 113 and 117 of CERCLA, 42 U.S.C. Sections 9613 and 9617, Langley AFB, in conjunction with the U.S. Environmental Protection Agency (EPA) and the Virginia Department of Environmental Quality (VDEQ), issued a *Proposed Plan* on September 13, 1998, presenting the preferred remedial alternative for OU-42⁴. The *Proposed Plan* and the supporting documentation were made available for review at that time and are among the documents which comprise the CERCLA Administrative Record for the OU.

The Administrative Record is available for review by the public at the following information repositories:

- Hampton Public library
Reference Section, Langley AFB Information Repository
4207 Victoria Boulevard
Hampton, Virginia 23669
(757) 727-1154
- Langley AFB
Administrative Record Room
37 Sweeney Blvd.
Building No. 328
Langley AFB, Virginia 23665-2107
(747) 764-1046

An announcement for a public meeting, the comment period, and the availability of the *Proposed Plan* and supporting documentation was published in the *Daily Press*, a newspaper of general circulation in Hampton, VA, on September 6, 1998. Additionally, this information was published in the *Flyer*, a Langley Air Force Base newspaper, on September 11, and September 18, 1998. This meeting was also announced at the previous Restoration Advisory Board Meeting, held on June 25, 1998.

The public comment period for the *Proposed Plan* was from September 13, 1998 to October 12, 1998. A public meeting was held at the Virginia Air and Space Center's Library in Hampton, Virginia, on September 24, 1998 to inform the public of the proposed no action alternative and to seek public comment. At this meeting, representatives from Langley AFB, EPA, and VDEQ were available to answer questions about conditions at OU-42 and the no action proposal for the soil for the OU. Responses to the comments received during this period are included in Section VIII (Responsiveness Summary) of this *Record of Decision* (ROD).

This ROD presents the selected remedial action for OU-42 which was selected in accordance with CERCLA and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). All documents considered or relied upon in reaching the remedy selection decision contained in this ROD are included in the Administrative Record for the OU and can be reviewed at the information repositories.

IV. Scope and Role of Operable Unit

This ROD describes the no action alternative selected for OU-42. This ROD addresses only the soil at OU-42. The groundwater at OU-42 is being investigated separately under CERCLA and will be addressed in a future ROD.

This document is the result of a Langley Partnership Team effort. The Langley Partnership, the IRP decision-making body, is composed of representatives from EPA Region a VDEQ, the U.S. Air Force Air Combat Command, Langley AFB, the U.S. Army Corps of Engineers, and environmental consultants.

V. Summary of Site Characteristics and Extent of Contamination

Summarized below are the relevant findings of the work to date with regard to contaminated soil located within the boundaries of OU-42.

A. Site Characteristics

The current land use of OU-42 is open space and recreational with the surrounding land use being mainly industrial. Area A is located near the RV storage yard and north of the main runway. Area B is located north of the flightline and is bordered by a jogging trail to the south with a playground, ballfield, and riding stables over 800 feet to the northeast and northwest, respectively. The land use of these areas is likely to remain the same; the OU is unlikely to be used for future residential use. However, the risk assessment conducted as part of the RI evaluated both recreational and residential human receptors should the current land use of the OU change.

The information below describes the land and groundwater resources available at OU-42.

1. Geology

The following geologic information was taken from the SI Report³. Surficial deposits (typically within the upper 5 feet) at Langley AFB consist mainly of Holocene alluvial deposits. These are primarily sandy, silty clays or silty, clayey sands. These sediments were deposited within the flood plains of the James, York, and Back Rivers during a period of higher sea level stands. There are also localized deposits of organic-rich soil, which were deposited in an estuarine or lagoonal environment. Fill material exists in several areas of the base, especially in the areas adjacent to the southwest branch of the Back River, where fill was used to stabilize the shoreline. This fill material is often similar to the native materials (due to its being derived from nearby borrow sources) and may contain gravel, rubble, and other construction debris.

The surficial deposits at Langley AFB are underlain by over 2,000 feet of sediments that range in age from early Cretaceous to Holocene. These overlie a pre-Cretaceous basement complex con-

sisting of sedimentary rocks together with granites and diorites. The basement complex is approximately 2,200 feet below the land surface at Langley AFB.

The Cretaceous deposits beneath the base occur at depths of approximately 700 to 2,200 feet below ground surface, and consist of discontinuous sand layers interbedded with silts and clays. The deposits are divided into two units: the Potomac Group (Lower Cretaceous) and the Mattaponi Formation (Upper Cretaceous). These Cretaceous deposits form the Principal Aquifer in Virginia, which yields large quantities of water in the Williamsburg and Yorktown areas.

The Cretaceous deposits are overlain by Paleocene sediments, consisting of fine to medium-grained sand interbedded with silty clays. These deposits are divided into three stratigraphic units:

- The Glauconitic Member of the Mattaponi Formation (oldest);
- The Aquia Formation; and
- The Nanjemoy Formation (youngest).

Strata of Eocene Age are divided into the Nanjemoy and Chickahominy Formations: however, these deposits are either thin or absent beneath Langley AFB.

Miocene deposits overlie the Paleocene strata beneath the base, and occur at depths of approximately 40 to 600 or 700 feet below land surface. They are divided into three units:

- The Calvert Formation (oldest);
- St. Mary's Formation; and
- Yorktown Formation (youngest).

The top part of the Miocene consists of shelly sediments cemented with calcite. These grade downward into a fine-grained quartz sand with decreasing shell content. The sands contain traces of biotite and glauconite.

The Miocene deposits are overlain by Pliocene sediments belonging to the Yorktown Formation. The formation consists of bluish-gray to greenish-gray, fossiliferous silts and fine sands with

localized shell beds and clayey silt lenses. Previous borings at Langley AFB encountered Yorktown formation deposits to a maximum depth of 17 feet below ground surface; however, the borings did not penetrate through the formation⁵. The deposits consisted of clayey sands and silty sands. A progressive downward color change from yellow-brown to bluish-gray was attributed to decreased weathering effects with depth.

The uppermost stratigraphic unit that occurs beneath the base is the Lynnhaven Member of the Tabb Formation (Pleistocene). This member is made up of a range of sediments, including estuarine clays, silt deposits, and sand and gravel beach deposits. Previous borings at the base encountered from 2 to 6 feet of Tabb Formation sediments, consisting primarily of brown clayey sands⁵.

2. Hydrogeology

There are three aquifer systems within the Coastal Plain sediments beneath Langley AFB: 1) the Shallow Water Table Aquifer; 2) the Upper Artesian Aquifer system; and 3) the Principal Artesian Aquifer system. None of these aquifers are used as sources of drinking water for Langley AFB because saltwater intrusion from the nearby Back River causes very high chloride concentrations in the groundwater. Even though the groundwater in this area is not used as a source of drinking water, individual homeowners have groundwater wells that have been used for watering lawns and washing cars. However, the Shallow Water Table Aquifer provides an important source of drinking water farther to the west in King Williams, Charles City, New Kent, James City, and York Counties. In Newport News and Hampton, there are areas where domestic groundwater is obtained from wells that range from 50 to 100 feet in depth. These wells are probably completed in the Shallow Water Table Aquifer, which ranges from 5 to 100 feet below land surface³.

3. Meteorology

The climate at OU-42 is influenced by Chesapeake Bay and the Atlantic Ocean to the east and by mountains to the west. Mild winters and warm, humid summers are the norm: Wintertime temperatures, range from the 30s to near 50 °F; summertime temperatures range from approximately 70 to the 80s.

Precipitation at OU-42 reaches maximum amounts in July and August, with minimum amounts in November and April; the annual average is 44.15 inches. In a given month, the average number of days with precipitation ranges from 7 to 11. In a given year, the average number of days with precipitation is 110. Snowfall averages 10 inches per year but is highly variable, ranging from 0 to 45 inches.

With an average wind speed of roughly 5 to 8 knots, the prevailing winds are south-southwest in April through May, southwest in June through September, and north in October through March.

4. Ecology

Both Area A and Area B of OU-42 are presently well-maintained grass lawns. These areas are small, less than an acre each, so ecological habitat is limited and of poor quality. OU-42 is considered terrestrial habitat only; there are no surface water bodies associated with the OU. The level of human activity prevents the OU from being used as an ecological habitat. However, small mammals (e.g., voles and mice) and passerine birds may use the area to forage for seeds and invertebrates at the OU.

5. Solis

Soils occurring at the surface consist of silty, clayey sands, with a low to moderate permeability. Contaminant migration via soil at OU-42 would be slow because of the low permeability and low hydraulic gradient. OU-42 is flat and covered with vegetation (i.e., grasses) that would prevent contaminant migration via wind-blown dust and surface runoff.

B. Nature And Extent Of Contamination

The SI consisted of drilling and sampling three soil borings in each area, installing one monitoring well in each area and collecting one sample from each of the wells. In 1998, the RI was performed; it consisted of the following samples: 1) two samples each from the existing monitoring wells, 2) direct push soil samples from three locations at each area, and 3) one deep direct push water sample. The RI data received Level IV data validation and therefore was used in a baseline risk assessment for OU-42.

The following is a summary of the sampling results of these investigations. Because this ROD addresses specifically the soil at OU-42, only the soil results are presented below.

1. OT-38 Area A

For the SL three soil borings were taken and analyzed for Resource Conservation and Recovery Act (RCRA) metals, extractable petroleum hydrocarbons, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), and SVOCs. Metals, VOCs, and SVOCs were detected in the soil samples at Area A. The screening assessment identified metals and SVOCs as the COPCs for Area A.

For the RI, three direct push locations were sampled at OT-38 Area A. Two soil samples were collected from each location. Figure 3 shows the location of the direct push samples. Direct push soil samples were collected from just below the surface (0 to 2 feet) and from just above the water table (2 to 5 feet). The samples were analyzed for organochlorine pesticides and PCBs, chlorinated herbicides, VOCs, SVOCs, polychlorinated dioxins and furans, metals, and total cyanide.

The near-surface (0- to 2-foot) soil samples from both of the direct push soil locations contained dieldrin in concentrations up to 128 F g/kg, a concentration which exceeds the dieldrin risk-based screening level (RBSL) of 40 F g/kg. The sample from location DPS3 (0 to 2 feet bgs) contained 6,020 ng/kg 1,2,3,4,6,7,8-OCDD, above the RBSL of 4,300 ng/kg. No background upper tolerance limit (UTL) for OCDD was determined. Figure 4 presents the location of these samples and the concentrations of dieldrin and OCDD.

Benzo(a)anthracene, fluoranthene, and mercury exceeded the background subsurface soil UTLs, but were lower than their corresponding RBSLs. Several of the direct push soil samples contained aluminum, beryllium, chromium, iron, manganese, and vanadium at concentrations greater than the RBSLs, but each of these metals is present in concentrations below background UTLs and are not attributable to OU contamination.

VOCs, PCBs, herbicides, and cyanide were not found at concentrations exceeding either the RBSLs or background UTLs in any of the direct push soil samples.

2. OT-38 Area B

For the SL three soil borings were taken and analyzed for RCRA metals, extractable petroleum hydrocarbons, PCBs, VOCs, and SVOCs. Metals, VOCs, and SVOCs were detected in the soil samples at Area B. The screening assessment identified several metals as the COPCs for Area B.

For the RI, three direct push locations were sampled at OT-38 Area B. Two soil samples were collected from each location. Figure 5 shows the location of the direct push samples. Direct push soil samples were collected from just below the surface (0 to 2 feet) and from just above the water table (2 to 5 feet). The samples were analyzed for organochlorine pesticides and PCBs, chlorinated herbicides, VOCs, SVOCs, polychlorinated dioxins and furans, metals, and total cyanide.

The only metal that exceeded the background subsurface soil UTL in the direct push samples was mercury. The direct push near-surface (0 to 2 feet) soil samples contained up to 0.0443 mg/kg mercury, and the subsurface (greater than 2 feet) samples contained up to 0.0377 mg/kg mercury, exceeding the background UTL, of 0.0294 mg/kg but below the RBSL of 0.78 mg/kg. Several of the direct push soil samples contained aluminum, arsenic, beryllium, chromium, iron, manganese, and vanadium at concentrations greater than the RBSLs, but each of these metals is present in concentrations below background UTLs and is, therefore, not attributable to site contamination.

Pesticides, SVOCs, VOCs, PCBs, polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), herbicides, and cyanide were not found at concentrations exceeding either the RBSL or background UTLs in any of the direct push soil samples.

3. Contaminant Fate and Transport

Only groundwater fate and transport modeling was conducted for OU-42 in the RI. Since this ROD addresses only soil for OU-42, fate and transport modeling results will be presented in the ROD addressing Basewide groundwater.

VI. Current and Potential Future Site and Resource Uses

Current land use at OU-42 is classified as open space and recreational. Future land use is expected to remain open space and recreational. There are currently no restrictions regarding use at OU-42, such as fences and signs. Land adjacent to OU-42 is currently industrial, open space and recreational. Future adjacent land is expected to remain the same.

VII. Summary of Site Risks

A risk assessment was conducted in the RI in accordance with the latest EPA policy on risk assessments⁶. The results are summarized below.

A. Human Health Risk Assessment

Health risks are based on a conservative estimate of the potential carcinogenic risk or potential to cause other health effects not related to cancer. Carcinogenic risks and non-carcinogenic risks were evaluated as part of the risk assessment; three factors were considered:

1. Nature and extent of contaminants at the OU;
2. The pathways through which human and ecological receptors are or may be exposed to those contaminants at the OU; and
3. Potential toxic effects of those contaminants.

For this OU, surface water and sediment were not evaluated because human health and ecological receptors are not exposed to this medium at this OU. Groundwater was addressed for the human health receptors, but groundwater results will be presented in a separate ROD.

Health risk levels, determined using EPA guidance to ensure that conservative estimates of potential health effects are determined, differ depending on the assumed land use because human exposure differs with land use. A conservative estimate of risk was developed, incorporating the potential exposure pathways of direct skin contact with contaminated soil, accidental ingestion of soil, and inhalation of contaminated particles. Plausible receptors that may be exposed to soil at the site and which were evaluated in the risk assessment included a groundskeeper and an on-site

resident (both child and adult exposure). Table 2 presents the exposure parameters and equations used to calculate risk levels for these receptors.

Cancer risks are expressed as numbers reflecting the increased chance that a person will develop cancer, if he/she is directly exposed (e.g., working at the OU) to the contaminants found in the soil over a period of time. For example, EPA's acceptable risk range for cancer is 1×10^{-4} to 1×10^{-6} , meaning there is one additional chance in ten thousand (1×10^{-4}) to one additional chance in one million (1×10^{-6}) that a person will develop cancer if exposed to a hazardous waste site. The risk associated with developing other health effects is expressed as a hazard index (HI). A hazard index of less than one means that a person exposed to a hazardous waste site is unlikely to experience adverse health effects. A hazard index is also used to evaluate ecological risks.

Concentrations of chemicals detected in the soil during the RI were compared to RBSLs and background levels. Chemicals that exceeded the screening levels were then used to calculate risk.

COPCs identified in the surface soil for OT-38 Area A were 1,2,3,6,7,8,9-OCDD and dieldrin; for subsurface soil, the COPCs identified were aluminum, iron, and vanadium. OT-38 Area B surface soil COPCs were identified as vanadium and aluminum; no COPCs were identified for OT-38 Area B subsurface soils.

Table 3 presents the risk results of the human health risk assessment for OU-42. The human health risk assessment concluded that the lifetime cancer risks to the receptors from exposure to pesticides and metals in soil at OT-38 Area A is 7×10^{-6} for the adult on-site resident. This lifetime risk is within EPA's acceptable risk range. The HI for the non-carcinogenic risks due to exposure to pesticides and metals in soils at OT-38 Area A is 0.12 for the groundskeeper and 0.02 for the on-site child resident. These values are below the acceptable level of 1.0, indicating that adverse non-carcinogenic health effects are unlikely to develop as a result of exposure through any of the exposure pathways.

No lifetime cancer risks exist to the receptors from exposure to metals in soil at OT-38 Area B. The HI for the non-carcinogenic risks due to exposure to metals in soils at OT-38 Area B is 0.07 for the groundskeeper and 0.3 for the on-site child resident. These values are below the accepta-

ble level of 1.0, indicating that adverse non-carcinogenic health effects are unlikely to develop as a result of exposure through any of the exposure pathways.

Ecological Risk Assessment

The ecological risk assessment evaluated exposure of terrestrial receptors to soil. Both Area A and Area B of the site are small (less than one acre) and are maintained grass lawns which provide only limited ecological habitat. No surface water or sediment exposure pathways exist at the site.

Only lead and dieldrin exceeded the HI of 1 for both areas. Upon further analysis, the HIs for lead and dieldrin dropped below an HI of 1.0 when the Lowest-Observed-Adverse-Effect-Level toxicity data were used instead of No-Observed-Adverse-Effect-Level toxicity data. Results indicate that there is minimal risk to terrestrial receptors at the site.

Conclusions

After evaluating the RI human health and ecological risk assessments, no action is considered necessary to protect human health and the environment at OU-42. The human health risk calculated under the current and future land use scenarios for Area A of OU-42 is within EPA's acceptable risk range, and Area B of OU-42 is below the EPA's acceptable risk range. Any adverse non-carcinogenic health effects are also unlikely to develop from the site as a result of exposure through any of the exposure pathways. Ecological risk assessment determined that there is minimal risk to terrestrial receptors at the site.

With the support of EPA and VDEQ, Langley AFB has selected no action as the preferred alternative for soil at OU-42; under this alternative, no remedial action would be undertaken there. The selection of no action is based on the conclusion, reached by the human health and ecological risk assessments, that the soils at the two areas comprising OU-42 pose no significant risk to potential human or ecological receptors; no action therefore would be protective of human health and the environment.

Following review and consideration of the information in the Administrative Record, the requirements of CERCLA and the NCP, and public comments received on the *Proposed Plan*, Langley AFB and EPA, in consultation with VDEQ, have selected the no action alternative as the remedy for OU-42.

VIII. Significant Changes from Proposed Plan

No significant changes were made from the Proposed Plan as a result of public review during the comment period or public meeting.

IX. Responsiveness Summary

A. Overview

In the *Proposed Plan* released for public comment on September 13, 1998, Langley AFB, with the support of EPA and VDEQ, identified no action as the preferred remedial alternative for OU-42. The no action alternative is described in the “Summary of the Proposed Remedy” in the *Proposed Plan*.

There were no written comments received as a result of the public comment period. There were no written comments submitted during the September 24, 1998 public meeting. There was one question presented orally at the public meeting concerning OU-42. The comment and the associated response of Langley, EPA, and VDEQ is provided below after a brief description of community involvement to date.

B. Community Involvement to Date

Langley, EPA, and VDEQ established a public comment period from September 13, 1998 to October 12, 1998 for interested parties to comment on the *Proposed Plan*. The plan and all other documents considered or relied upon during the remedy selection process for the no action alternative are included in the Administrative Record, which is available for public review. A public meeting was held at the Virginia Air and Space Center, Hampton, Virginia, on September 24,

1998 to present the proposed plans, answer questions, and accept both oral and written comments on OU-42. Two people attended the public meeting.

This responsiveness summary, required by CERCLA, provides a summary of citizen comments made during the public meeting and the responses of Langley AFB, EPA, and VDEQ. Responses to these comments are included in the section below.

C. Summary Of Comments Received During Public Comment Period and Comment Responses

In the public meeting held on September 24, 1998, two proposed plans for Langley AFB were presented. One was for OU-42 (Waste Oil and Trash Bum Pits), and the other was for OU-47 (the Former Electrical Substation Site). Following is the only comment which pertained to OU-42:

Comment # 1:

What is each of your backgrounds and what kind of experience do you have to be in the positions that you are in?

Response # 1:

The EPA representative stated that she has been working with Federal CERCLA sites, including other DOD installations, for six years.

The VDEQ representative stated that he had been working with Federal CERCLA sites, including other DOD installations, for six years.

The Langley representative stated that he had been working in the Air Force environmental program for twelve years.

Each of the representatives stated that they had college degrees in disciplines related to their current positions.

APPENDIX A

Tables

Table 1. Summary of Operable Units Under CERCLA Investigation**Page 1 of 2**

OU Name/IRP Site Name	Findings	Current Status
OU-21/LF-01 Former Landfill, End of 08/26 Runway	Contaminates of Potential Concern (COPCs) - pesticides and metals in the groundwater and soil.	In the remedial investigation (RI) phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-22/WP-02 Former Waste Water Treatment Plant, HTA Area, Bldg 724	COPCs – pesticides and metals in the groundwater and soil.	In the RI phase. A draft RI report will be submitted by mid-1999.
OU-23/LF-05 Former Landfill in the Shellbank Area	COPCs – pesticides, VOCs, and metals in the groundwater; pesticides and metals in the surface water; and SVOCs and metals in the soil.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-24/OT-06 Former Entomology Site, Shellbank Area	COPCs – pesticides, VOCs, SVOCs, and some metals in the groundwater; SVOCs, pesticides and some metals in the soil.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-25/LF-07 Former Landfill, Shellbank Area	COPCs – pesticides and some metals in the groundwater; dieldrin in the soil.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-26/WP-08 Former Waste Water Treatment Plant, LTA Area	COPCs – some pesticides and metals in the groundwater; dieldrin in the soil.	In the RI phase. A draft RI report has been submitted and reviewed.
OU-28/LF-10 Former Landfill, Golf Course	COPCs – VOCs, metals and some pesticides in the groundwater; VOCs and PCBs in surface water; some metals in the soil.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-29/LF-11 Former Landfill, Tabbs Creek Area	COPCs – VOCs, pesticides, metals and PCBs in the groundwater; some metals in the surface water; SVOCs, metals and PCBs in the soil.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-30/LF-12 Former Landfill, Munition Storage Area, Northwest Area of Base	COPCs – VOCs and metals in the groundwater; metals and 2,4-DB in the surface water; SVOCs and nickel in the soil.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-31/LF-13 Former Landfill, Munitions Storage Area, Northwest Area of Base	COPCs – Aldrin, alpha-BHC and some metals in the groundwater; VOCs, SVOCs, metals and PCBs in the surface water.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-32/WP-14 Former Chemical Leach Pit, Firing-In Abutment, Building 1303	COPCs – pesticides, SVOCs, and some metals in the groundwater; arsenic and dieldrin in the soil.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-33/LF-15 Former Landfill, Willoughby Point	COPCs – VOCs, SVOCs, pesticides, and metals in the groundwater; pesticides and metals on the surface water.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.

Table 1. Summary of Operable Units Under CERCLA Investigation**Page 2 of 2**

OU name/IRP Site Name	Findings	Current Status
OU-34/LF-17 Former Landfill, Lighter Than Air Area	COPCs – VOCs, pesticides and some metals in the groundwater; dieldrin and some metals (mainly lead) in the soil.	In the RI phase. A draft RI report will be submitted by mid-1999.
OU-35/LF-18 Former Landfill, Northwest Corner Base	COPCs – pesticides in the groundwater; pesticides and metals in the surface water; SVOCs and manganese in the surface soil; delta-BHC and metals in the sediment.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-37/LF-22 Former Landfill, Willoughby Point	COPCs – pesticides and metals in the groundwater; alpha-BHC, delta-BHC and metals in the surface water.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-40/OT-25 Old Entomology Building and Former Storage Area, Bldg 965	COPCs pesticides in the groundwater and soil.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway.
OU-42/OT-38A and B Four Waste Oil and Trash Burn Areas, Basewide	Risk assessments showed no significant risk to human health or the environment.	In the ROD Phase for soils. Groundwater ROD will follow at a later date. The final RI report was submitted in September 1998.
OU-44/FT-41 Former Fire Training Area Firing-In Abutment, Bldg 1303	COPCs – VOCs, pesticides, dioxins, and some metals in the groundwater; SVOCs, dioxins and some metals in the surface water.	In the RI phase. A draft RI report has been submitted and reviewed. A separate basewide ecological risk assessment is currently underway
OU-47/OT-51 Former Electrical Substation, Shellbank Area, Bldg 82	COPCs – pesticides, PCBs and lead in the soil.	The RI report and proposed plan have been finalized. The record of decision is due to be submitted by the end of 1998.
OU-48/OT-55 Civil Engineering Yard, Underground Petroleum Contamination	COPCs – pesticides and dieldrin in the groundwater; pesticides and PCBs in the soil.	In the RI phase. A draft RI report is due to be submitted by mid-1999
OU-49/OT-56 Silver Contamination in Storm Sewers, Basewide	COPCs – metals and VOCs in surface water and metals, SVOCs, and pesticides in sediment.	In the feasibility study (FS) phase. The FS is due to be finalized by mid-1999.
OU-50/SS-61 Old Civil Engineering Paint Show/Marina	COPCs – VOCs in the groundwater and soil.	In the proposed plan (PP) phase. The PP is due to be finalized by the end of 1998.
OU-51/SS-63 Back River Sediments	COPCs – pesticides, metals and PCTs in the sediment.	In the PA/SI phase. The draft PA/SI report is due to be submitted by the end of 1998.
OU-52/OT-64 Groundwater Contamination Basewide	COPCs – pesticides and metals in the groundwater.	In the scoping phase. The LTM project is due to be awarded by mid-1999.

Table 2. Exposure Parameters and Equations Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors at Langley AFB, Virginia
Page 1 of 4

Exposure Parameter	Pathway Variable	Groundskeeper	Off-Base Resident
Inhalation of VOCs and Resuspended Dust from Soil $I_a = \frac{C_a \times I_{ra} \times F_{la} \times E_{ta} \times EF \times ED}{BW \times AT}$			
Inhalation Intake of COPC in Soil	Ia (mg.kg-day)	calculated	calculated
Concentration of COPC in Air	Ca (mg/m ³)	CSV	CSV
Inhalation Rate	Ira (m ³ /hour)	2.5 ^a	NA
Fraction of Exposure Attributed to Site Medium	Fla (unitless)	1 ^c	NA
Exposure Time	ETa (hours/day)	8 ^d	NA
Exposure Frequency	EF (days/year)	50 ^c	NA
Exposure Duration	ED (years)	RME: 25 ^a CT: 9 ⁱ	NA
Body Weight	BW (kg)	70 ^a	NA
Averaging Time (non-carcinogens)	AT Non-cancer (days) ^e	RME: 9,125 CT: 3,285	NA
Averaging Time (carcinogens)	AT Cancer (days) ^f	25,550	NA
Incidental Ingestion of Soil $I_s = \frac{C_s \times I_{rs} \times F_{ls} \times EF \times ED \times CF_4}{BW \times AT}$			
Ingested Intake of COPC in Soil	Is (mg/kg-day)	calculated	calculated
Concentration of COP in Soil	Cs (mg/kg)	CSV	CSV
Conversion Factor	CF4 (kg/mg)	1E-06	1E-06
Ingestion Rate of Soil	Irs (mg/day)	50 ^a	Child RME: 200 ^a Child CT: 100 ^b
Fraction of Exposure Attributed to Site Medium	FIs (unitless)	1/0.5 ^j	1 ^c

Table 2. Exposure Parameters and Equations Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors at Langley AFB, Virginia

Page 2 of 4

Exposure Parameter	Pathway Variable	Groundskeeper	Off-Base Resident
Exposure Frequency	EF (days/year)	50 ^c	350 ^g 234 ^b
Exposure Duration	ED (years)	RME: 25 ^a CT: 9 ⁱ	Child RME: 6 ^g Child CT: 1.8 ⁱ
Body Weight	BW (kg)	70 ^a	Child 15 ^g
Averaging Time (non-carcinogens)	AT Non-cancer (days) ^f	RME: 9,125 CT: 3,285	Child RME: 2,190 Child CT: 657
Averaging Time (non-carcinogens)	AT Cancer (days) ^f	25,550	25,550
Incidental Ingestion of Soil (Age-Adjusted Resident - Cancer Evaluation)			
$I_s = \frac{C_s \times IFS_{adj} \times EF \times CF \times FIs}{AT}$			
Ingested Intake of COPC in Soil	Is (mg/kg-day)	NA	calculated
Concentration of COPC in Soil	Cs (mg/m ³)	NA	CSV
Age-adjusted Ingestion Factor	IFSadj (mg-yrs/kg-day)	NA	RME: 114 CT: 57
Fraction of Exposure attributed to Site Medium	FIs (unitless)	NA	1 ^c
Exposure Frequency	EF(days/year)	NA	350 ^g 234 ⁱ
Averaging Time (carcinogens)	AT Cancer (days) ^f	NA	25,550
Dermal Contact with Soil			
$DAD = \frac{C_s \times CF_4 \times AF \times ABS \times CF_5 \times SA \times c \times Fld \times EF \times ED}{BW \times AT}$			
Average dermally absorbed dose of COPC	DAD (mg/kg-day)	calculated	calculated
Concentration of COPC in Soil	Cs (mg/kg)	CSV	CSV
Conversion Factor	CF4 (kg/mg)	1E-06	1E-06
Conversion Factor	CF5 (event/day)	1	1
Fraction of Exposure Attributed to Site Medium	Fld (unitless)	1	1

Table 2. Exposure Parameters and Equations Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors at Langley AFB, Virginia
Page 3 of 4

Exposure Parameter	Pathway Variable	Groundskeeper	Off-Base Resident
Surface Area of Skin Available for Contact with Soil	Sa (cm ²)	2000 ^h	Child RME: 1825 ^c Child CT: 1825 ^c
Exposure Frequency	EF (days/year)	50 ^c	RME: 350 ^a CT: 234 ^b
Exposure Duration	ED (years)	RME: 25 ^a CT: 9 ⁱ	RME: 6 CT: 1.8
Body Weight	BW (kg)	70 ^a	15 ^c
Soil-to-Skin Adherence Factor	AF (mg/cm ²)	0.2 ^h	0.2 ^h
Absorption Fraction	ABS (unitless)	C _{sv}	CSV
Averaging Time (non-carcinogens)	AT Non-cancer (days) ^e	RME: 9,125 CT: 3,285	RME: 2190 CT: 57
Averaging Time (carcinogens)	AT Cancer (days) ^f	25,550	NA
Dermal Contact with Soil (Age-Adjusted Resident-Cancer Evaluation)			
$DAD = \frac{C_s \times SFS_{adj} \times ABS \times AF \times EF \times CF \times Fld}{AT}$			
Average dermally absorbed dose of COPC	DAD (mg/kg-day)	NA	calculated
Concentration of COPC in Soil	C _s (mg/kg)	NA	CSV
Age-adjusted Skin Contact	SFS _{adj} (cm ² -yr/kg-day)	NA	RME: 2720 CT: 730
Absorption Fraction	ABS (unitless)	NA	CSV
Skin-to-Soil Adherence Factor	AF (mg/cm ²)	NA	0.2 ^h
Exposure Frequency	EF (days/yr)	NA	RME: 350 ^a CT: 234 ⁱ
Conversion Factor	CF (kg/mg)	NA	1E-06
Fraction of Exposure Attributed to Site Medium	Fld (unitless)	NA	1
Averaging Time (carcinogens)	AT Cancer (days) ^f	NA	25,550

Table 2. Exposure Parameters and Equations Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors at Langley AFB, Virginia

Page 4 of 4

NA = not applicable; CSV = chemical-specific value; RME = reasonable maximum exposure; CT = central tendency

- ^a *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors*, Interim Final, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, OSWER Directive: 9285-03. 1991.
- ^b *Exposure Factors Handbook*, Office of Health and Environmental Assessment, Washington, DC, EPA/600/8-89/043. U.S. Environmental Protection Agency. 1990.
- ^c Assumed, see *Remedial Investigation Report for IRP Site OT-38A and B, Draft Final, Langley Air Force Base, Virginia*. Radian International, May 1998.
- ^d Default value based on conversation with EPA Region III and VDEQ. Site-specific evaluation may be used to justify a different exposure time.
- ^e Calculated as the product of ED (years) x 365 days/year.
- ^f Calculated as the product of 70 years (assumed human lifetime [*Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)*, Interim Final, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC EPA/540/01-8/8002, 1989]) x 365 days/year.
- ^g *Risk-Based Concentration Table*, March 14, 1997, EPA Region III, Philadelphia, PA, on-line.
- ^h *Dermal Exposure Assessment: Principles and Applications*, Interim Report. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, including Supplemental Guidance dated August 18, 1992.
- ⁱ *Attachment 2, Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure*, Preliminary Review Draft, U.S. Environmental Protection Agency, May 5, 1993.
- ^j FI = 1 unless site-specific considerations indicate that exposure to more than one potentially contaminated medium is applicable. For example, if a receptor is exposed to two potentially contaminated media, FI = 0.5. In addition, some smaller portion of the assumed intake may be attributable to contaminated media, and, therefore, FI may vary, as described in text.

Note: This table presents the variables used to estimate potential chemical intakes and contact rates for Langley AFB. This table is not specific to any IRP site and does not represent exposure scenarios for any site.

Table 3. Human Health Risk Assessment Summary for OU-42 (OT-38 Area A and Area B)

Media of Concern	Groundskeeper	Adult Resident	Child Resident
OT-38 Area A Receptor Hazard Index			
Surface Soil	—	NA	0.02
Subsurface Soil	0.12	NA	NA
OT-38 Area A Cancer Risk			
Surface Soil	—	7E-06	NA
Subsurface Soil	NC	NA	NA
OT-38 Area B Receptor Hazard Index			
Surface Soil	<0.1	NA	0.3
Subsurface Soil	NC	NA	NA
OT-38 Area B Cancer Risk			
Surface Soil	NC	NC	NA
Subsurface Soil	NC	NA	NA

NA = Not applicable; pathway not evaluated

NC = Not calculated; chemical-specific factor(s) not available.

-- = Pathway evaluated; risk value is <0.001 (Hazard Index) or 1E-06 (Cancer Risk).

APPENDIX B

Figures

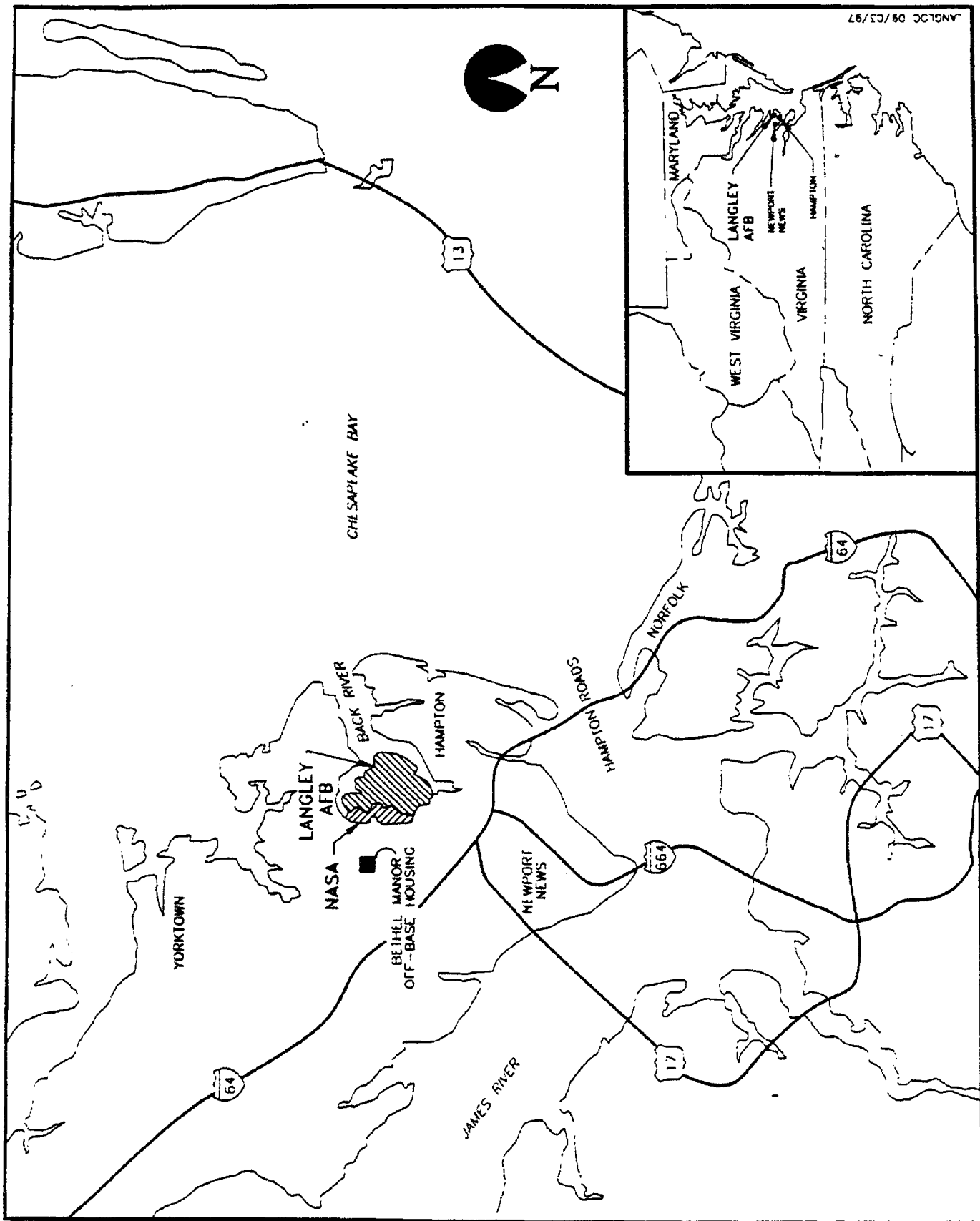


Figure 1. Location Map, Langley Air Force Base, Virginia

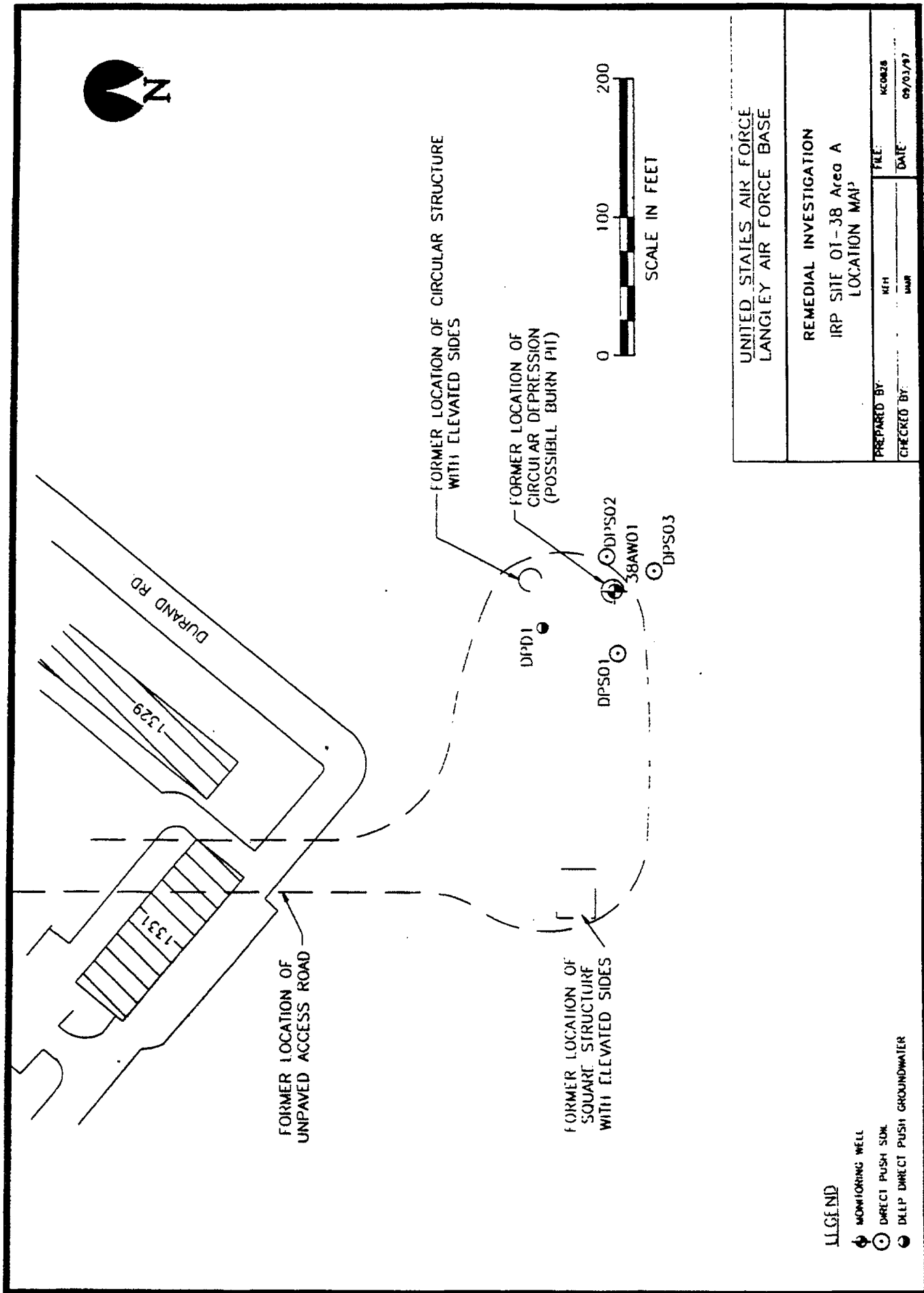


Figure 3. OT-38 Area A Sampling Locations

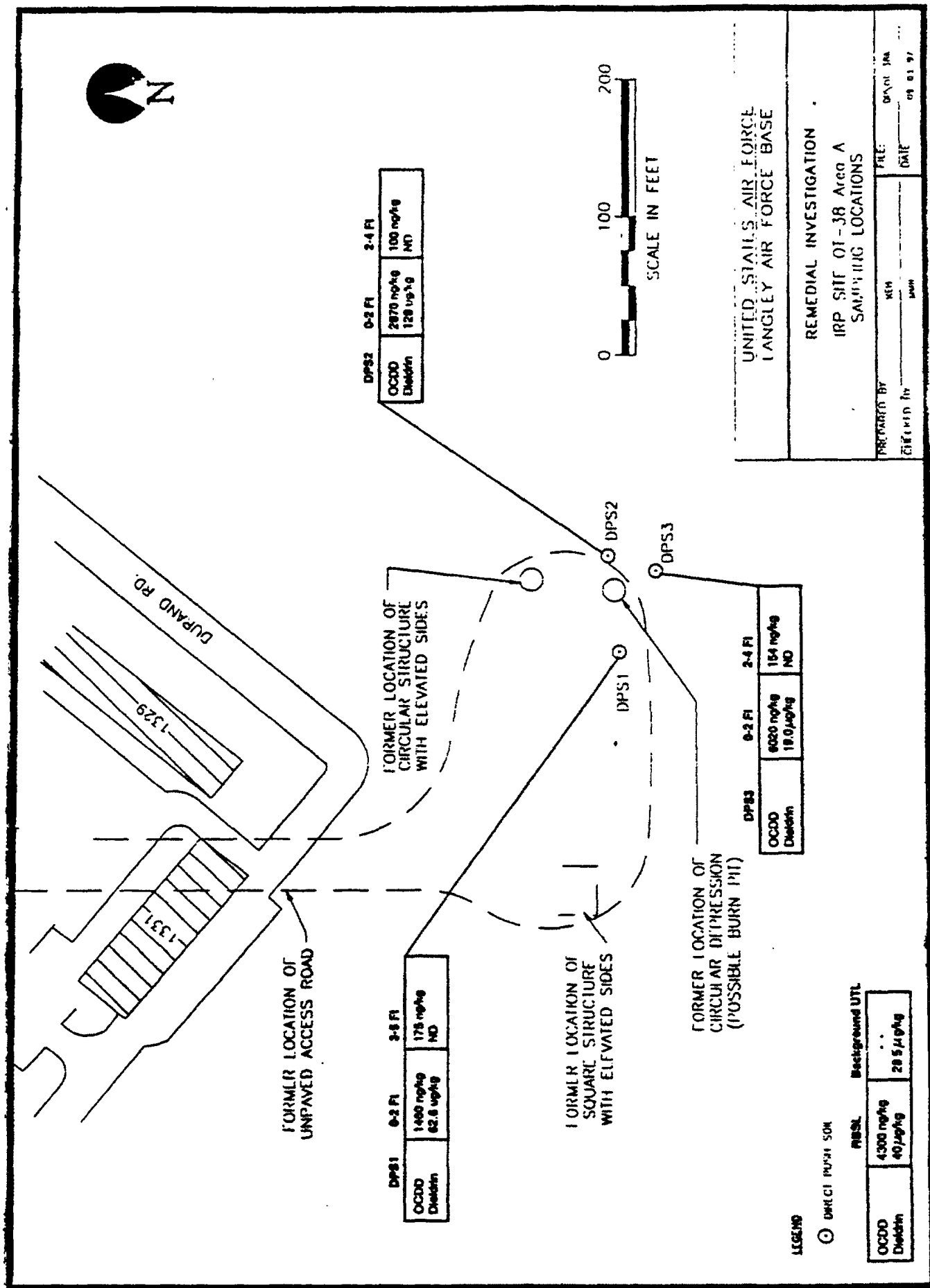


Figure 4. OT-38 Area A Direct Push Soil Results Greater than RBSLs and Background UTLs

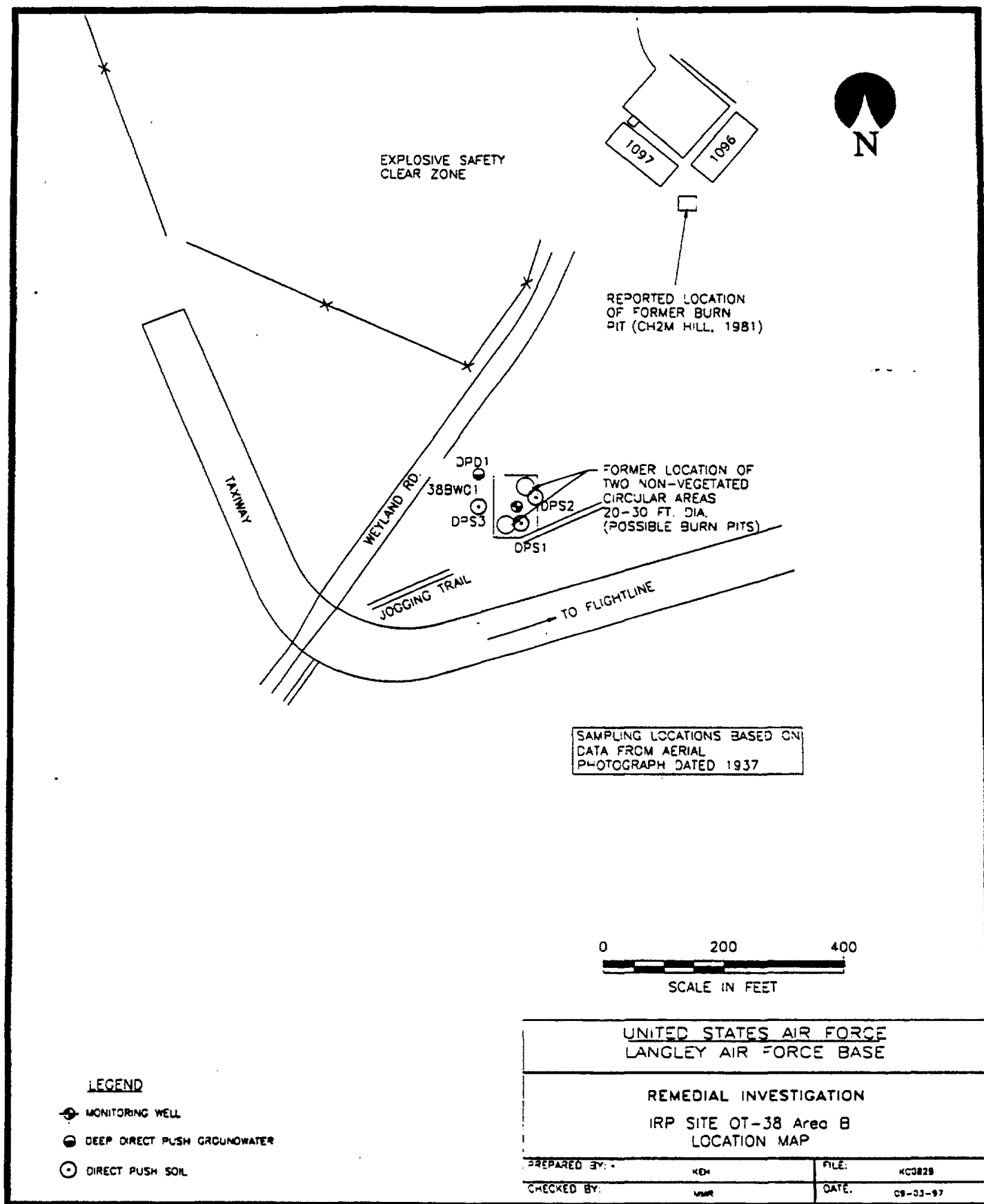


Figure 5. OT-38 Area B Sampling Locations

APPENDIX C

GLOSSARY

Administrative Record: A collection of documents containing all the information and reports generated during the entire phase of investigation and cleanup at the site and used to make a decision on the selection of the preferred alternative under CERCLA.

Carcinogenic Risk: Cancer risks are expressed as numbers reflecting the increased chance that a person will develop cancer if exposed to chemicals or substances. For example, EPA's acceptable risk range for Superfund sites is 1×10^{-4} to 1×10^{-6} . This means that the probability of cancer should not be greater than 1 in 10,000 chance to a 1 in 1,000,000 chance above background.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): A federal law, commonly referred to as the Superfund Program, passed in 1980 that provides for the cleanup and emergency response in connection with numerous existing inactive hazardous waste disposal sites that endanger public health and safety of the environment.

Chemicals of Potential of Concern (COPCs): Chemicals, either present at the site as a result of historical activities or of likely concern to human health and the environment, which are evaluated in the risk assessment.

Ecological Risk Assessment: An evaluation of the risk posed to the environment if remedial activities are not performed at the site.

Exposure Pathways: Describes the course a chemical or physical agent takes from the source to the exposed individual. Elements of the exposure pathway are: (1) the source of the released chemical; (2) the contaminated medium (e.g., soil); (3) a point of contact with the contaminated medium; and (4) an exposure route (e.g., ingestion, inhalation) at a contact point.

Hazard Index (HI): A number indicative of non-carcinogenic health effects which is the ratio of the existing level of exposure to an acceptable level of exposure. A value equal to or less than one indicates that the human population is not likely to experience adverse effects.

Human Health Risk Assessment: An evaluation of the risk posed to human health should remedial activities not be implemented.

Installation Restoration Program (ERP): Program established by the United States Air Force to systematically identify and remediate contaminated sites. The IRP was designed to be consistent with EPA rules and guidelines.

Lowest-Observed-Adverse-Effect Level (LOAEL): The lowest exposure level at which there are statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control group.

No-Observed-Adverse-Effect Level (NOAEL): An exposure level at which there are no statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered as adverse, nor as precursors to adverse effects. In any experiment with several NOAELs, the regulatory focus is primarily on the highest one, leading to the common usage of the term NOAEL as the highest exposure without adverse effect.

Operable Unit (OU): A discrete portion of a site or a discrete action representing an incremental step in the investigation and remediation of hazardous substances at a facility.

Proposed Plan: A document that presents a proposed cleanup alternative and requests public input regarding the proposed alternative.

Record of Decision (ROD): A legal document that describes the cleanup action or remedy selected for a site, the basis for the choice of that remedy, and public comment on alternative remedies.

Remedial Action: Implementation of plans and specifications, developed as part of the design, to remediate a site.

Remedial Investigation (RI): Part of a study of a facility that supports the selection of a remedy for a site where hazardous substances have been disposed. The RI identifies the nature and extent of contamination at the facility.

Site: The facility and any other areas in close proximity to the facility where a hazardous substance, hazardous waste, hazardous constituent, pollutant, or contaminant from the facility has been deposited, stored, disposed of, or placed or has migrated or otherwise come to be located.

Site Inspection (SI): The SI determines if the site presents an immediate threat that requires prompt response action because the site may pose a threat to human health and/or the environment.

Site-Related Risk: Cancer and non-cancer risk estimates that are based on contaminants present in environmental media due to site-specific human activities at Langley AFB, but that exclude the contribution of background contaminant concentrations.

Superfund Amendments and Reauthorization Act (SARA): An amendment to CERCLA enacted in 1986.

APPENDIX D

References

1. *Remedial Investigation Report for IRP Site OT-38A and B*, (draft final), Langley Air Force Base, Virginia. Radian International LLC, May 1998.
2. *Installation Restoration Program Records Search for Langley Air Force Base, Virginia*. Gainesville, Florida. CH2M Hill, June 1981.
3. *Installation Restoration Program (IRP) Site Inspection and Screening Risk Assessment Report for 33 IRP Sites* [draft]. Radian Corporation, February 1996.
4. *No Action Proposed Plan for: OU-42 (OT-38 Areas A and B), Langley Air Force Base* [final]. Langley AFB, September 1998.
5. *Final Site Investigation Report for Site Investigations at Four IRP Sites, Langley Air Force Base, Hampton, Virginia*. Law Environmental, Inc., Government Services Division, Kennesaw, Georgia, March 1990.
6. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual*. OSWER Directive 9285.7-01a, Office of Emergency and Remedial Response, Washington, D.C. U.S. Environmental Protection Agency, 1989.